Case study

Productivity Improvement Through Work StudyTechniques: A Case of a Modern Rice Mill in Ikwo, Ebonyi State

ABSTRACT

Aim: To explore the use of the work-study techniques in the efficiency improvement in the productivity of a firm or industry. A firm's profit can be increased through productivity improvement by reducing non-value-added operations and adopting a new process for a particular activity.

Study design: Currently, productivity improvement is a crucial factor in industries. Therefore, one of the primary goals of this firm is to improve productivity which enhances its long-run profit. The most critical tool for enhancing the firm's productivity is work study. Hence, this study noted the bottleneck and provided an appropriate technique for productivity improvement.

Place and Duration of Study: A modern rice mill inIkwoEbonyi State Nigeria, between March 2021 and October 2022.

Methodology: A method study was carried out using well-designed questionnaire techniques with interconnected critical analysis of a particular production line. A reasonable work content reduction was obtained when the proposed improvement method was applied. A stopwatch was used to obtain the time study with much emphasis on the standard time for the operation sequences. As a result, each workstation capacity per day was calculated.

Results: The result shows that the firm productivity index improved by 14.29% when method study and work measurement were applied in the production line. Implementation of the proposed production line improved productivity from the old production line by 14.29%. Previously, the work content per ton was 4892mins. Considering the line balancing and critical analysis of the proposed technique, the proposed work content took 3649mins to be completed, this leads to a reduction of work content by 1243mins after the line balancing and analysis. The proposed method helps to increase productivity to 14.29% with 25.41% reduction of work content and line balancing.

Conclusion: In the Ikwo modern rice mill, productivity improvement is considered a critical factor for increasing the profit margin. Therefore, an increase in the profitable index of the firm is the function of productivity improvement, as a result of proper planning and control of the available input variables.

Keywords: Production; Productivity improvement; Work study; Method study; Work measurement

1. INTRODUCTION

Production is any method or technique established to transform a certain set of input into a unique set of output in the right quantities and quality while achieving an industry's goals. Through the transformation of raw materials, production facilities the development of finished goods [1]. The systematic diagram of a typical rice mill production system is shown in Fig. 1.

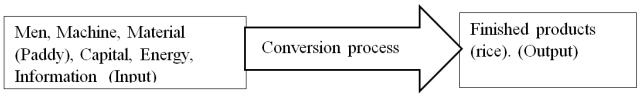

Fig. 1. Production system [1].

Productivity is defined as the ratio of the value produced to the resources needed for the production [2]. A productivity index is typically calculated as a component of productivity measurement used to compare output quantities with input resources [2, 3]. Thus,

$$Productivity = \frac{Output}{Input} \quad (1)$$

Productivity is used to determine the quantities of output products produced from a given quantity of input materials [4]. Currently, productivity measurement is a critical factor in industries. It is important to note that, the profit enhancement of any firm is a function of its productivity improvement with respect to the input variables. The reduction of non-value-added processes and other bottlenecks in a production cycle helps to improve productivity and facilitates customer satisfaction [5]. [6] Noted the correlation between the productivity and output and material utilization techniques, output prices, inventory management, and distribution time. Profit increase is a result of productivity improvement [7].

Elimination of wastes, process repair, techniques modification, process simulation, minimization of input variables, and increase in output quality and decrease in set-up-time are other ways to increase a firm's productivity. An increase in the quantity of value-added processes brings about an increase in productivity [8].

[3, 9, 10] Noted that productivity could be improved if production cost per unit and labour cost are reduced with proper balancing of the production line. [3, 11] Defined productivity as the method of improving production at a constant production rate. This study x-ray the application of the work-study technique in a production line of Ikwo modern rice mill to enhance the firm productivity. Increased profit and effective labour utilization in a firm can be obtained when improved productivity is achieved via work study [6].

The main focus of this study is to determine how Ikwo modern rice mill can improve its productivity by applying the work-study technique. A critical management model for increasing productivity is work study. It deals with men, work methods, and performance efficiency of a firm. For a firm to survive in a competitive environment depends on the use of modern technology and economic manufacturing processes [12]. Effective utilization of the machine, man, capital, and energy, helps to improve production efficiency. Proper implementation of work-study, with much emphasis on method analysis and performance evaluation, aids in improving production efficiency. To achieve the same or greater efficiency at a reduced cost, work is divided into smaller units, studied, and redesigned. [13] Classified Work study is a methodology that integrates method study and works measurement techniques to ensure the proper allocation of men and material resources while producing a specific product.

It is a managerial function with a focus on method study and work measurement that is used to determine labour efficiency and to investigate all the available resources that have a direct impact on the economy and increase production efficiency.
.According to [13], the goal of work-study is to reduce costs by either planning the work for maximum productivity or increasing the productivity of the current work by making changes in existing processes through the elimination of non-value-added processes. As a result, it leads to a direct method of increasing productivity.
Consequently, it can be considered to be a practical method of increasing productivity. Work study has a close connection to productivity advancement since it is widely used to enhance the production capacity from a given set of resources with little to no additional capital investment [13].
[14] Stated that work-study is a practical methodology, specifically method study and work measurement used to determine the labour efficiency and to evaluate all the input variables that affect the effectiveness and economy of the existing problems under review in order to improve productivity. This shows that work-study is a direct method of increasing or enhancing productivity as a result of its capability to analyze human labor, which influences efficiency, as well as production improvement.
[15] Suggest that productivity and work-study are correlated as a tool to increase profitability. It is widely utilized to increase output while requiring little to no more input from a given set of resources. Several factors, including labor, material, land, machines, capital, technology, product, and management, have a direct impact on a firm's productivity and profitability.
[19] Noted that for productivity improvement to take place in any company, the workers need to work within their limits to enhance balancing in the production line.
[20] Suggested that improvement in productivity can also be achieved through effective utilization of available capital, labour, material and modern machines.
[21] Examined increase in productivity through delivery of products to the customers at the right time and right quantity.
[22] Reviewed Productivity increase by means of a work study using manufacturing industry as the area of interest.

Innovative processes and the installation of modern machinery are two effective long-term productivity drivers. But a significant amount of funds is needed for this operation. Additionally, attempts to increase productivity through the use of modern technology may have an impact on initiative to increase job opportunities.
The goal of work study, on the other hand, is to increase productivity by objectively analyzing the current operations, processes, and work practices in order to increase their efficiency with little to no additional capital expenditure. It is necessary to use work study effectively and throughout the production processes in order to achieve productivity improvement. As a result, the International Labour Organization has demonstrated the correlation between work study and increased productivity.

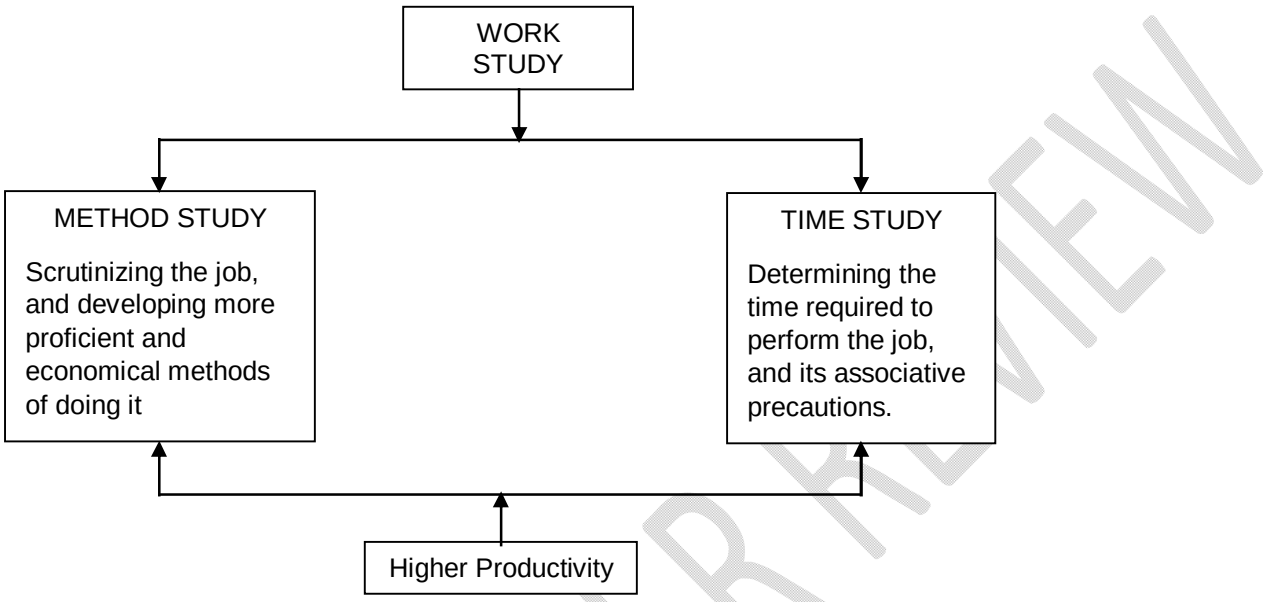

Fig. 2. Work Study Methods [13].

This conceptual diagram is used to analyze the production line using a specific set of products. We chose the Ikow modern rice mill for this study to analytical evaluate its existing methods and time study with a stopwatch. We compute the standard time from the observed time for each operation, while the performance rate of the workers was computed using a rating system and two forms of allowance. The goal of this study is to increase productivity by analyzing the firm's manufacturing process using the work study approach. Identifying current production problems and devising new approaches via technical evaluation.

2. MATERIAL AND METHODS

In order to reduce the work content of the selected product, we adopted step by step procedure to achieve productivity improvement through work study method. To achieve the stated goal we developed a conceptual framework for the study, we first selected Ikwo rice mill to the study its production line. All the operations in the production line were observed with the help of stopwatch. At the point of observing the operation the existing problem was identified through questioning technique. After that a new method or process for the product was developed. The practical application of the new proposed method in a particular production line showed that the productivity has been improved.
The following tools were employed to enable us collect and analyzed the data collected for the study. These include:

2.1 Time observed

[16] Defined it as the time taken to carry out a single operation or series of operations, which can be determined through direct measurement

2.2 Time considered

The time chosen as being representative of a group of times for an operations or group of work by calculating mean, median or mode.

2.3 Rating

This is used to evaluate the worker's productivity in relation to the researcher's perception based on the method employed. [17] Presented the widely accepted rating system as presented in table 1.

Table 1. Rating system [17].

Rating (%)	Explanation
≤ 0	Zero Activity
Up to 50	Operations too slow, loss of interest to perform jobs
Up to 75	No compromised performance while on job, No waste of time, effective supervision of the workers
Up to 100	Serious business orientation, use of skilled labourers, standard quality and right production rate
Up to 125	Operators show interest, fast moving operations, under well-coordinated materials flow
≥ 150	Little or no supervision, exceptional performance by outstanding workers

2.4 Basic time

This is the minimum time needed to produce a unit output from available input resources. According to [17] it is the time required to perform some activity at a given specification or standard.

$$Basic\ Time = \frac{Observed\ Time\ x\ Observed\ Rating}{Standard\ Rating} \quad (2)$$

2.5 Standard time

This is a job cycle time at a standard performance (Time needed to complete on operation) [17].

$$Standard\ Time = Basic\ time + Allowances \quad (3)$$

In this study, 15% and 3% relaxation and contingency allowances respectively were considered.

2.6 Relaxation allowance

This is the important aspect of the time that can be added to the basic time to determine the standard time to produce a particular product. Allowances given to a worker depend upon the type of job performed. 15% of the basic time was generally accepted as a relaxation allowance added to determine standard time [18].

2.7 Contingency allowance

This is the minimum time estimated while planning for unexpected production activities. This time should added to the basic time to determine the standard time for time studies [18]. 3% contingency was chosen for our study.

$$Efficiency = \frac{Present\ Output}{StandardCapacity} \quad (4)$$

$$Increasing\ Efficiency = \left[\frac{(The\ efficiency\ of\ proposed\ line - Present\ efficiency}{Present\ efficiency}\right] x\ 100 \quad (5)$$

$$\%\ of\ work\ content\ reduction\ per\ ton = \left[\frac{(Present\ work\ content/ton - Proposedcontent/ton}{Present\ work\ content/bag}\right] x\ 100 \quad (6)$$

$$Increasing\ productivity\ at\ (100\%\ capacity) = \left[\frac{(Proposed\ Standard\ output - Existing\ output}{Existing\ output}\right] x\ 100 \quad (7)$$

3. COLLECTED DATA AND ANALYSIS

In order to achieve our research objective practically, a modern rice mill Ikwo was selected for real-life implementation. On milled rice, observation was done on each production line with respect to time study. We observed that 18 operations were involved in a complete production cycle. Based on this, we observed and computed time for the 18 operations with the aid of a stopwatch.In each operation, five observed times were taken to determine the time for an operation to be completed. From the data obtained, the basic times were calculated

using a specific rating point for a worker as stated in equation (2). Equation (3) was used to calculate the standard time including relaxation and contingence allowances. Based on this, standard time of 8 hours working time were considered for each worker.

Table 2. Existing operations in Ikwo rice mill in minutes

S/No.	Name of the operations	Observed times in minutes					Selected Time	Rating	Basic Time	Standard Time	Manual or m/c	Man power	Capacity/Day@100% efficiency
		1	2	3	4	5							
1	Loading & off load of paddy	566	560	490	545	550	542	80	434	512	Manual	6	857
2	Steam heating of paddy	273	262	279	269	275	271	80	217	295	Manual	5	563
3.	Drenching	108	118	120	111	115	114	80	91	169	Manual	4	897
4	Soaking	330	370	340	290	350	340	80	272	380	Manual	6	1500
5	Clearing	240	250	235	246	238	242	85	206	284	Manual	8	592
6	Drying	400	370	320	420	350	370	80	296	374	Sun	10	1371
7	Inspection	105	110	100	120	118	111	85	94	172	Manual	3	873
8	Husking	250	225	240	255	228	240	80	192	270	M/c	4	527
9	Polishing	220	230	270	190	250	230	80	184	262	M/c	6	2286
10	Milling	230	221	225	235	218	225	80	180	258	M/c	7	453
11	Destoning	208	230	220	227	223	223	80	178	256	M/c	4	457
12	Whitening	188	192	180	178	185	185	85	157	235	M/c	2	519
13	Length Grading	450	400	420	440	390	420	80	336	414	Manual	2	1200
14	Inspection	112	101	99	114	108	107	85	91	169	Manual	2	449
15	Shifting	129	126	123	139	138	131	85	111	189	Manual	6	733
16	Blending	259	275	250	265	269	263	85	224	302	Manual	4	727
17	Final Inspection	58	65	60	67	60	62	85	53	131	Manual	2	1524
18	Weighing & Bagging	177	170	167	188	185	177	80	142	220	Manual	12	857
									3258	**4892**		**93**	

Fig. showed the flow chart of the existing production line

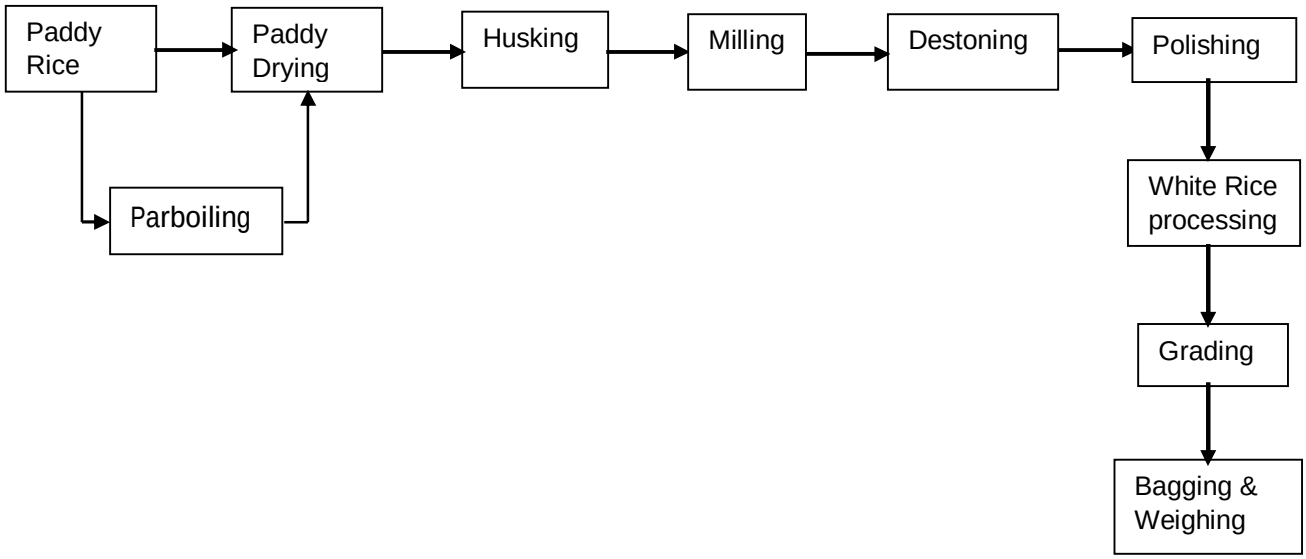

Fig. 3. Production flow chart for the existing method

3.1 Analysis of data

3.1.1 Proposed production line for the firm

We observed a significant improvement on some of the identified problem while implanting the proposed techniques on the existing operations. We did some important operations to improve the productivity of the

selected product. In table 3 the vital activities carried out while implementing our research approach were presented

.

Table 3. Critical analysis of operation

Operation	Existing Line Existing method	Standard Time/ton	Proposed Line Suggested method	Standard Time/ton
Cleaning of paddy	Removing all impurities and unfilled grains from the paddy is generally done using a single screen bed oscillating. This usual need more time.	284	Due to large quantity of the paddy required, it is could done with double screen bed oscillating with an aspiration. This type of method makes cleaning quicker than existing method	126
Husking	Removing the husk from the paddy is generally done using Steel husker. The using Steel husker for husking need more time. It has low milling efficiency and produces high amount of cracked and broken rice.	270	We could use rubber rollers operating at different speeds. It has high milling efficiencies of 80% to 90% with minimum broken or cracked grain. Due to speed variation a quicker technique could be used to save time.	238
De-stoning	Separating small stones from the brown rice is done manually. The using of manual method to separate stones from rice need more time.	256	Apply mechanized tools to save time.	64
Inspection	Inspection is done in de-stoning.	172	Should be avoided it in de-stoning section,	0
Polishing	Improving the appearance of milled rice by removing remaining bran particles and by polishing the exterior of the milled kernel. This is done using friction – friction – polishing. This method need more time than a mist method.	262	We could use a mist method to brush off remaining dust and to create a characteristics gloss on the milled rice. This method save time.	198
Weighing and bagging	Preparing milled rice for transport to the customer. This is done using bags, filled manually and closed by the bag stitchers. Due to the nature of the top, it need more skilled worker and more time.	220	If we could use mechanized bagging with closing –sawing machine and weighing with digital weighingmachine. This method save time and also improve productivity.	167

Table 4 showed the operations and time analysis of the proposed production line balancing.

Table 4. Production line balancing as proposed for Ikwo rice mill

S/No	Operation	Time observed (mins)	Rating (%)	Basic Time (mins)	Standard Time (mins)	Machine or Manual	Labour capacity	Production capacity per day @ 100% efficiency	Production capacity per day @ 85% efficiency
1	Loading & off load of paddy	542	80	434	512	Manual	6	281	2390
2	Steam heating of paddy	107	80	86	164	Machine	2	763	590
3	Soaking	340	80	272	380	Manual	6	2880	1542
4	Clearing	60	80	48	126	Machine	3	700	595
5	Drying	80	80	64	142	Machine	3	1560	880
6	Inspection	120	85	102	180	Manual	2	1536	1056
7	Polishing	120	80	96	174	Machine	3	2800	1680
8	Husking	200	80	160	238	Machine	3	980	756
9	Milling	225	80	180	258	Machine	7	1000	920
10	Destoning	107	80	86	164	Machine	2	690	580
11	Whitening	185	85	157	235	Machine	2	700	640
12	Length Grading	110	85	94	172	Machine	1	1700	1400
13	Inspection	107	85	91	169	Manual	2	580	540
14	Shifting	60	80	48	126	Machine	2	1100	935
15	Blending	102	85	87	165	Machine	2	1600	1200

16	Final Inspection	120	85	102	180	Manual	1	2182	1850
17	Weighing & Bagging	105	85	89	167	Machine	3	1210	1029
				2196	3552		50		

Fig.4 showed the flow chart of the proposed production line

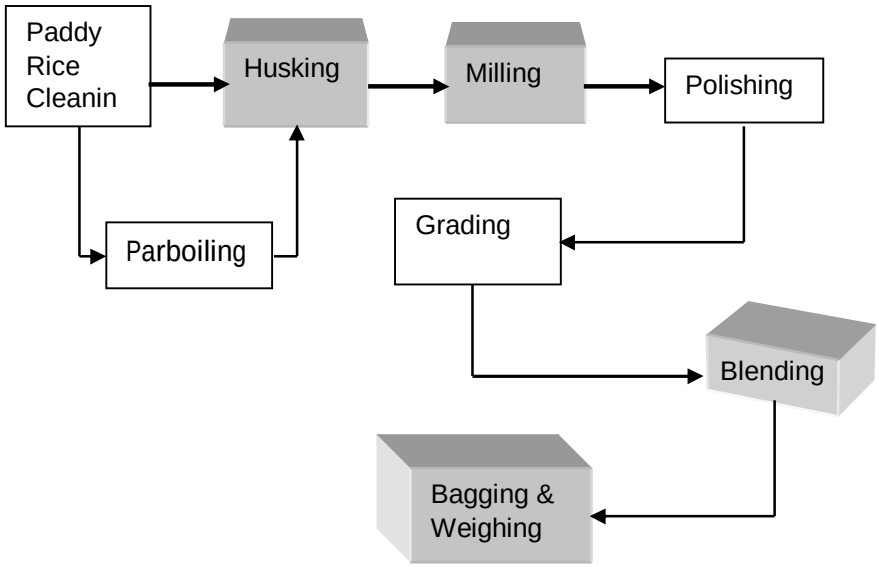

Fig. 4. Production flow chart for the proposed method

4. RESULTS AND DISCUSSION

The firm documents showed that the existing production linehas a production capacity of 1050bags of 50kg per day. The firm has 8 hours working days. It also showed that the total number of workers on the same production line is 93 persons, therefore, following equation (1), the production line has mean production capacity of about 52.5tons per day. The total operating time on the production line was 480mins as recorded, then when equation (3) is applied the standard time per day (present work content) obtained was 4892mins and 93.18mins as the standard time per ton.

The documents showed that the firm standard production capacity under 100% efficiency was175tons per day. When equation (4) is applied 30% efficiency was obtained. This efficiency value showed that the existing production line operates low production capacity, with a direct impact on the productivity of the firm.

The present work content per ton was 4892 mins. Considering the line balancing and critical analysis of the proposed technique, the proposed work content took 3649mins to be completed, this leads to a reduction of work content by 1243mins after the line balancing and analysis. This represents 25.41% of work content reduction per ton.

The proposed production line under the standard production efficiency of 100% produced 200 tons per day. Then the daily output for the existing standard production line was175 tons. When equation (7) was applied, 14.29% increase in productivity was obtained.

In this study, implementation of the proposed production line improved productivity from the existing production line by 14.29%.Our new approach, which includes balancing of production line and reduction in job content improved productivity by 14.29%. Our proposed method helps to increase productivity to 14.29% with 25.41% reduction of work content and line balancing.

5. CONCLUSION

The study has shown that in Ikwo modern rice mill, productivity improvement is considered a critical factor for increasing the profit margin. Therefore, an increase in the profitable index of the firm is the function of productivity improvement, as a result of proper planning and control of the available input variables.

The study identified the differences between processes and operations while producing an output. The study also identified how to determine the limitations of production operations and processes of producing a particular product.
Productivity improvement can be achieved by putting time and method studies into practice, as well as adopting method methodology for specific operations. Productivity improvement of a product also depends upon a proper balancing of the production line. We were unable to use this method for other products due to the time factor. For effective reduction of activities and tasks for productivity improvement, the best technique to be employed for such a goal is lean manufacturing.The study demonstrates how reducing work content and balancing the production line affect the productivity of the firm.

Finally, I recommend that further research could be on the integration of lean manufacturing and work-study technique.

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